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Introduction to the Federal Radionavigation Plan

This section describes the background, purpose, and scope of the Federal Radionavigation Plan (FRP). It summarizes the events leading to the preparation of this document, the national objectives for coordinating the planning of radionavigation services, national policy on radionavigation systems, and radionavigation authority and responsibility.

1.1 Background

The first edition of the FRP was released in 1980 as part of a Presidential Report to Congress, prepared in response to the International Maritime Satellite (INMARSAT) Act of 1978. It marked the first time that a joint Department of Transportation (DOT) and Department of Defense (DOD) plan for common-use (both civil and military) systems had been developed. Now, this biennially updated plan serves as the planning and policy document for all present and future Federally provided common-use radionavigation systems.

A Federal Radionavigation Plan is required by 10 U.S.C. 2281(c) (Ref. 1). A Memorandum of Agreement (MOA) between DOD and DOT provides for radionavigation planning as well as for the development and publication of the FRP. This agreement recognizes the need to coordinate all Federal radionavigation system planning and to attempt, wherever consistent with operational requirements, to utilize common systems. In addition, a memorandum of agreement between the DOD and DOT on the

civil use of the Global Positioning System (GPS) establishes policies and procedures to ensure an effective working relationship between the two Departments regarding the civil use of GPS. The March 28, 1996 Presidential Decision Directive (PDD) (Ref. 2) on GPS provides a comprehensive national policy and guidelines on the future management and use of GPS. An Interagency GPS Executive Board (IGEB), jointly chaired by the Departments of Defense and Transportation, manages the dual civil/military use GPS and U.S. Government augmentations and supports the implementation of GPS national policy in accordance with the provisions of the PDD. The IGEB ensures that GPS and U.S. augmentations are operated in a manner that is consistent with national policy and that best serves the military and civil user communities. As directed by the PDD, the IGEB consults with U.S. Government agencies, U.S. industries, and foreign governments involved in navigation and positioning system research, development, operation, and use. In addition to DOD and DOT, IGEB membership currently includes the Department of State (DOS), Chairman, Joint Chiefs of Staff (CJCS), Department of Commerce (DOC), Department of Interior (DOI), Department of Agriculture (DOA), Department of Justice (DOJ), and the National Aeronautics and Space Administration (NASA). The IGEB management structure is shown in Figure 1-1. A detailed discussion of U.S. Government agency roles and responsibilities is contained in Appendix A.

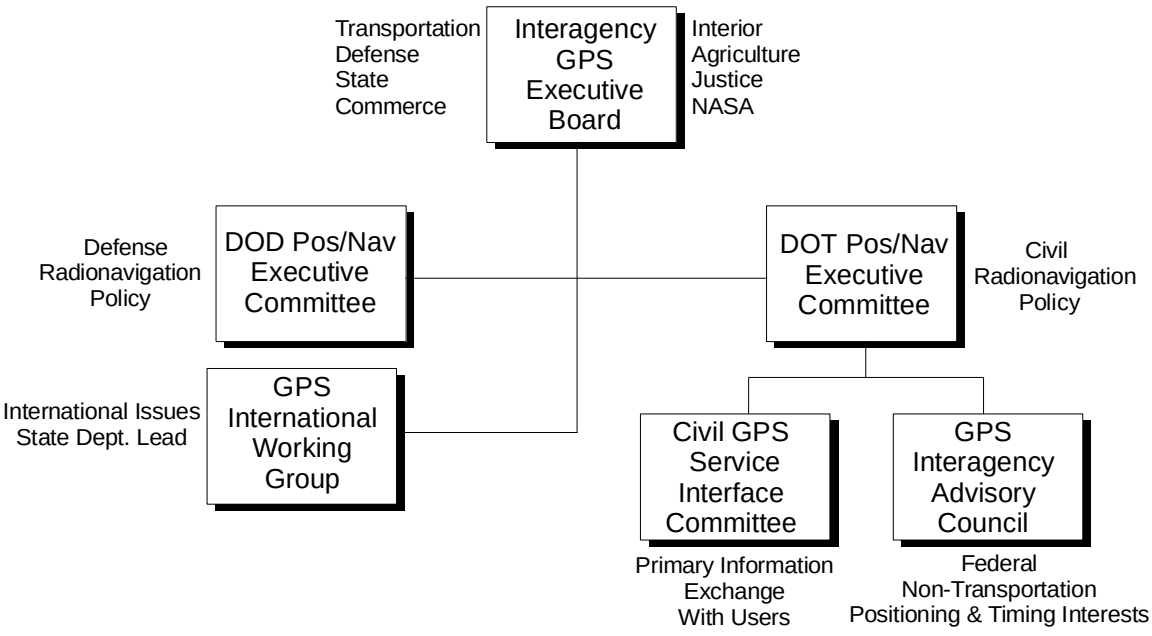

Figure 1-1. Interagency GPS Executive Board Management Structure

The 1990 FRP included, for the first time, discussions of land uses of radionavigation systems. This 1999 FRP includes expanded discussions on new and developing applications, including the extensive use of radionavigation systems in positioning, surveying, timing, weather research, and many other areas.

The Federal Government holds open meetings every two years to provide the user community with the opportunity to comment on Federal radionavigation system policies and plans as published in the FRP. In 1998, user meetings were held in Long Beach, CA and Washington, DC. The meetings were very well attended, with a broad spectrum of users representing the private sector; Federal, state, and local government agencies; and academic institutions. Aviation, land, marine, and space navigation interests were represented, as well as other applications for radionavigation systems, such as precise timing, positioning, geodesy and surveying, and weather research. Comments focused on support for use of GPS; concerns with relying on a single radionavigation system (i.e., GPS) without backup or complementary systems and support from the general aviation community for continuing Loran-C beyond the current phaseout date.

The need to consolidate and reduce the number of navigation systems as GPS is phased in is a major objective of DOD and DOT. The constantly changing radionavigation user profile and rapid advancements in systems technology require that the FRP remain as dynamic as the issues it addresses. The current DOD/DOT policy on the radionavigation systems mix is presented in Section 1.7.

1.2 Purpose

The purpose of the FRP is to:

- Present the current Federal policy and plan for common-use civil and military radionavigation systems.
- Document radionavigation requirements and address common-use systems and applications.
- Outline the Government's approach for implementing new and consolidating existing radionavigation systems.
- Provide government radionavigation system planning information and schedules.
- Define and clarify new or unresolved common-use radionavigation system issues.
- Provide a focal point for user input.

1.3 Scope

This plan covers Federally provided, common-use radionavigation systems. The plan does not include systems that mainly perform surveillance and communication functions.

The systems addressed in this FRP are:

- GPS

- Augmentations to GPS
- Loran-C
- VOR and VOR/DME
- TACAN
- ILS
- MLS
- Radiobeacons

1.4 Objectives

The radionavigation policy of the United States is a product of the balancing of a myriad of national interests.

The objectives of U.S. Government radionavigation system policy are to:

- Strengthen and maintain national security.
- Provide safety of travel.
- Promote efficient transportation.
- Help protect the environment.
- Support peaceful civil, commercial, and scientific applications of radionavigation systems.

1.5 Practices and Procedures

The following U.S. Government practices and procedures support the above objectives:

a. Provide and operate radio aids to navigation which contribute to safe, expeditious, and economic air, land and maritime commerce and which support United States national security interests in accordance with international agreements.

b. Avoid unnecessary duplication of radionavigation systems and services. The highest degree of commonality and system utility between military and civil users is sought through early consideration of mutual requirements.

c. Consider electromagnetic spectrum requirements in the planning and management of radionavigation systems.

d. Promote transportation safety and environmental protection by requiring certain aircraft and vessels to be fitted with radionavigation equipment as a condition for operating in the controlled airspace or navigable waters of the United States.

e. Evaluate domestic and foreign radio aids to navigation, with support for the development of those systems having the potential to meet unfulfilled operational requirements or those offering major economic advantages over existing systems.

f. Establish suitable system transition periods for systems being phased out based on user equipage and acceptance, spectrum transition issues, budgetary considerations, and the public interest.

g. Promote international exchange of scientific and technical information concerning radionavigation aids.

h. Guide and assist siting, testing, evaluating, and operating non-Federal and private radio aids to meet unique aviation and land transportation requirements.

i. Promote national and international standardization of civil and military radionavigation aids.

j. Publish system and signal standards and specifications.

k. Provide the minimum number of special radionavigation aids and services for military operations.

l. Limit availability of radionavigation systems operated by the U.S. Government subject to direction by the National Command Authority (NCA) in the event of a real or potential threat of war or impairment to national security.

m. Equip military vehicles, as appropriate, to satisfy civil aviation and maritime navigation safety requirements. However, the primary concern will be that U.S. military vehicles and users are equipped with navigation systems which best satisfy mission requirements.

n. Establish mechanisms, where practical, for users of Federally provided radionavigation systems to bear their fair share of the costs (except for direct charges for basic GPS signals) for development, procurement, operation, and maintenance of these systems.

o. Consider, in accordance with the national policy contained in OMB Circular A-76 (Ref. 3), the extent to which the private sector can participate in the design, development, installation, operation, and maintenance of all equipment and systems required to provide common-use radionavigation aids (within the constraints of national security).

1.6 Radionavigation Systems Selection Considerations

Many factors are considered in determining the optimum mix of Federally provided radionavigation systems. These factors include operational, technical, economic, institutional and international parameters. System accuracy, integrity, and coverage are the foremost technical parameters, followed by system availability and reliability. Radio frequency spectrum issues also must be considered. Certain unique parameters, such as

anti-jamming performance, apply principally to military needs but also affect civil availability.

The current investment in ground and user equipment must also be considered. In some cases, there may be international commitments that must be honored or modified in a fashion mutually agreeable to all parties.

In most cases, current systems were developed to meet distinct and different requirements. This process resulted in the proliferation of multiple radionavigation systems and was the impetus for early radionavigation planning. The first edition of the FRP was published to plan the mix of radionavigation systems and promote an orderly life cycle for them. It described an approach for selecting radionavigation systems to be used in the future. Early editions of the FRP, including the 1984 edition, reflected that approach with minor modifications to the timing of events. By 1986, it became apparent that a final recommendation on the future mix of radionavigation systems was not appropriate and major changes to the timing of system life-cycle events were required. Consequently, it was decided that starting with the 1986 FRP, a current recommendation on the future mix of radionavigation systems would be issued with each edition of the FRP. The 1999 recommendation reflects policy direction from the PDD (Ref. 2), advances in radionavigation technology, changing user profiles, budget considerations, international activities and input received at radionavigation user conferences sponsored by DOT and DOD.

The Federal Government will solicit and consider inputs from users of radionavigation systems in the decision-making process on radionavigation systems. Developments in GPS augmentations and the changing user needs will be reviewed. The status and impact of commercial systems will also be considered as a part of this process. In addition, as an alternative to the phasing out of civil radionavigation systems, consideration may be given to the possibility of phasing over their operation to the private sector.

When the need or economic justification for a particular system appears to be diminishing, the Department operating the system will notify the appropriate Federal agencies and the public, by publishing the proposed discontinuance of service in the Federal Register.

In the final analysis, provision of Government services for meeting user requirements is subject to the budgetary process, including authorizations and appropriations by Congress, and priorities for allocations among programs by agencies. A more detailed discussion of selection considerations is contained in Appendix B.

1.7 Federal Policy on the Radionavigation System Mix

This section contains the current U.S. Federal radionavigation policy and plans.

Federal Radionavigation System Policy and Plans (1999 Federal Radionavigation Plan)

Purpose:

This statement sets forth the policy and plans for Federally provided radionavigation systems.

Objectives:

The Federal Government operates radionavigation systems as one of the necessary elements to enable safe transportation and encourage commerce within the United States. It is a goal of the Government to provide this service in a cost-effective manner. In order to meet both civil and military radionavigation needs, the Government has established a series of radionavigation systems over a period of years. Each system utilizes the latest technology available at the time of introduction to meet existing or unfulfilled needs. This statement addresses the conditions under which each system may be part of Federal radionavigation system policy and plans.

The Department of Defense (DOD) has deployed a dual-use (civil and military) satellite-based radionavigation system, the Global Positioning System (GPS). The services provided by this system and its civil augmentations meet or exceed the services provided by many existing radionavigation systems. Additional improvements in GPS are planned to improve the service provided to both the civil and military users of the system. As the full civil potential of GPS and its augmentations are realized, the service provided by other Federally provided radionavigation systems is expected to decrease to match the reduction in demand for those services.

One of the objectives of this plan is to reflect anticipated changes in radionavigation services provided by the Federal Government. This plan will continuously evolve to reflect the needs of users of Federal radionavigation services. When the benefits derived by the users of a service drop below the cost of providing that service, the Federal Government can no longer continue to provide that service. A number of factors go into anticipating these benefits. Navigation standards establish which service or combination of services is sufficient to conduct an operation. A suitable transition period will be established based on user equipment availability, radio spectrum transition issues, cost and acceptance, budgetary considerations, and the public interest. Operational or safety considerations may dictate the need for a complementary service to support navigation to conduct certain operations. International commitments dictate certain levels and types of navigation services to ensure interoperability with international users.

Although radionavigation systems are established primarily for safety of transportation, they also provide significant benefits to other civil, commercial, and scientific users. In recognition of this, any changes to Federal operation of radionavigation systems will consider the needs of these users.

Radionavigation systems operated by the U.S. Government are available as directed by the National Command Authority (NCA) in the event of war or threat to national security. Operating agencies may cease operations or change characteristics and signal formats of radionavigation systems during a dire national emergency. All communication links, including those used to transmit differential GPS corrections and other GPS augmentations, are also subject to the direction of the NCA.

Individual System Plans:

GPS:

GPS, a 24-satellite-based radionavigation system operated by the DOD and managed by the Interagency GPS Executive Board, provides two levels of service – a Standard Positioning Service (SPS), which uses the C/A code on the L1 frequency, and a Precise Positioning Service (PPS) which uses the P(Y) code on both L1 and L2 frequencies. SPS is available to all users on a continuous, worldwide basis, for the foreseeable future, free of any direct user charge. The SPS accuracy is currently degraded globally through the use of a technique called selective availability (SA). U.S. Government policy is to discontinue the use of SA by the year 2006.

The specific capabilities provided by SPS are established by DOD and DOT and are published in the *Global Positioning System Standard Positioning Service Signal Specification**, available through the USCG Navigation Information Service. In recognition that GPS receivers utilize the entire transmitted bandwidth of the GPS signal at L1, the first sentence of paragraph 2.3.1.1 of the SPS Signal Specification was recently amended to read, "The L-band SPS ranging signal is a 2.046 MHz null-to-null bandwidth signal centered about L1. The transmitted ranging signal that comprises the GPS-SPS is not limited to the null-to-null signal and extends through the band 1563.42 to 1587.42 MHz."

Although the L2 is currently not part of the Standard Positioning Service, many civil users currently employ dual frequency receiver technologies to support their requirements. Consequently, the U.S. Government has determined that availability of not one, but two additional C/A coded signals is essential for many critical uses of GPS. The additional signals are planned to enhance the ability of GPS to support all civil users. A second non-safety-of life coded signal will be added at the GPS L2 Frequency (1227.60 MHz) on the satellites scheduled for launch beginning in 2005. A third civil signal that can meet the needs of critical safety-of-life applications such as civil aviation will be added at 1176.45 MHz.

*U.S. Department of Defense, 2nd edition, June 2, 1995.

The third signal will be implemented on the satellites scheduled for launch beginning in 2007. It is planned that both the second and third civil signals may become part of a civil GPS service. Until the second coded civil GPS signal is operational, the DOD will not intentionally reduce the current received minimum radio frequency signal strength of the P(Y)-code signal on the L2 link, as specified in the Interface Control Document (ICD) GPS 200, nor will the DOD intentionally alter the modulation codes, as known today, to generate the current P(Y)-code on the L2 link. This does not preclude additions of other codes or modifications to the L2 signal which do not change or make unusable the current L2 P(Y)-coded signal and its modulation codes.

Augmentations to GPS:

When augmented to satisfy civil requirements for accuracy, coverage, availability and integrity, GPS will be the primary Federally provided radionavigation system for the foreseeable future.

Augmentations to GPS are enhancements to the GPS SPS to meet unique requirements. Augmentations to GPS fall into two categories: 1) differential GPS (DGPS), and 2) additional inputs from non-GPS navigation systems, equipment, or techniques.

The U.S. Government will not constrain the peaceful use of SPS-based DGPS services that are consistent with U.S. and international agreements.

Maritime DGPS Service: The USCG declared Full Operational Capability (FOC) of the Maritime DGPS Service on March 15, 1999. The USCG system provides service for coastal coverage of the continental U.S., the Great Lakes, Puerto Rico, portions of Alaska and Hawaii, and portions of the Mississippi River Basin. Maritime DGPS uses fixed GPS reference stations that broadcast pseudo-range corrections using radionavigation radiobeacons. The Maritime DGPS Service system provides radionavigation accuracy better than 10 meters (2 drms) for U.S. harbor entrance and approach areas. The USCG is continuing to validate the current system's ability to meet the needs of the harbor entrance and approach and inland phases of navigation.

Nationwide DGPS: Seven Federal agencies are expanding the Maritime DGPS Service to cover all surface areas of the United States to meet the requirements of surface users. A seven agency Memorandum of Agreement has been jointly signed by the Federal Railroad Administration (FRA), the Federal Highway Administration (FHWA), the USCG, the U.S. Air Force, the Office of the Secretary (DOT), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Army Corps of Engineers (USACE). The predictable accuracy of the NDGPS Service within all established coverage areas is better than 10 meters. Fielded operations are achieving accuracies of better than 3 meters.

	Wide Area Augmentation System (WAAS): The Federal Aviation Administration (FAA), in cooperation with other DOT organizations and DOD, is augmenting the GPS/SPS with a satellite-based augmentation system, the Wide Area Augmentation System. The initial operational capability of WAAS will begin by the end of 2000, and will provide en route through nonprecision approach service as well as a limited precision approach capability. After achieving initial operational capability, the WAAS will then be incrementally improved over the next six years to expand the area of coverage, increase the availability of precision approaches, increase signal redundancy, and reduce operational restrictions. The result of these incremental improvements will enable aircraft equipped exclusively with WAAS avionics to execute all phases of flight in the NAS except Category II and Category III precision approaches. **Local Area Augmentation System (LAAS)**: The LAAS, a ground-based augmentation system, is expected to provide the required accuracy, integrity, and availability for Category II and Category III precision approaches, as well as to increase the availability of CAT I services where WAAS will not meet CAT I service performance requirements. LAAS may be used to support runway incursion warnings, high-speed turnoffs, missed approaches, departures, vertical takeoffs and surface operations.
Loran-C:	Loran-C provides coverage for maritime navigation in U.S. coastal areas. It provides navigation, location, and timing services for both civil and military air, land and marine users. Loran-C is approved as an en route supplemental air navigation system for both Instrument Flight Rule (IFR) and Visual Flight Rule (VFR) operations. The Loran-C system serves the 48 conterminous states, their coastal areas, and parts of Alaska. While the Administration continues to evaluate the long-term need for continuation of the Loran-C radionavigation system, the Government will operate the Loran-C system in the short term. The U.S. Government will give users reasonable notice if it concludes that Loran-C is not needed or is not cost effective, so that users will have the opportunity to transition to alternative navigation aids.
Omega:	Omega ceased operation as a navigation, positioning, and timing system on September 30, 1997.
VOR/DME:	VOR/DME provides users with a means of air navigation in the National Airspace System (NAS). VOR/DME will continue to provide navigation services for en route through nonprecision approach phases of flight throughout the transition to satellite-based navigation. The FAA plans to reduce VOR/DME services provided in the NAS based on the anticipated decrease in use for en route navigation and instrument approaches. The phase-down of VOR/DME is expected to begin in 2008.
TACAN:	TACAN is the military counterpart of VOR/DME. The azimuth service of TACAN primarily serves military users only while the DME service serves both military and civil users. The DOD requirements for land-based TACAN will terminate when aircraft are equipped with GPS and are approved by the individual

DOD Services for operations in national and international controlled airspace. The requirement for sea-based TACAN will continue until a suitable replacement is operational. The phase-down of TACAN will be based on its decreased utility as an en route navigation and nonprecision approach aid by DOD. Target date to begin the phase-down is 2008.

Precision Approach Systems:

The Instrument Landing System (ILS) is the predominant system supporting civil precision approaches in the U.S. With the advent of GPS-based precision approach systems, the role of ILS will be reduced. Factors in planning the phase-down of ILS service will include assessment of progress with GPS-based precision approaches and the economic utility of continued ILS service on a per-approach basis. ILS may continue to be used to provide precision approach service at major terminals. The phase-down of Category I ILS is expected to begin in 2008.

Limited WAAS Category I precision approach service is expected to be available beginning in 2000. ILS service will be provided for a transition period to allow users to equip with WAAS receivers and to gain confidence in its service.

The FAA expects LAAS Category II/III precision approach systems to be available for public use by 2003 at a few selected airports. Based on current plans for implementing Category II/III LAAS and the anticipated service life of Category II/III ILS equipment, the FAA does not anticipate phasing out any Category II/III ILS systems prior to 2015.

The DOD has established the Joint Precision Approach and Landing System (JPALS) program to provide its next generation precision approach and landing capability. JPALS will provide U.S. forces a global precision landing capability in a variety of mission environments and under a wide range of meteorological conditions. Assuming a successful risk reduction effort, JPALS plans to begin phasing in new capabilities as early as 2004.

In April 1995, ICAO endorsed the Global Navigation Satellite System (GNSS) as the core system for international use and canceled the requirement for international runways to be equipped with the Microwave Landing System (MLS) by January 1, 1998 except when operationally required and economically justified. ICAO also extended the ILS protection date to January 1, 2010. This date is not to be confused with Europe's requirement for aircraft to be equipped with FM immune ILS and VHF communication transceivers by January 1, 2001. The U.S. will continue to promote the international acceptance and implementation of GPS for navigation in all phases of flight.

The FAA has terminated the development of MLS based on favorable GPS test results and budgetary constraints. The U.S. does not anticipate installing additional MLS equipment in the NAS but could purchase systems on the

open market for Category II/III operations if the need should arise in the future. The phase-down of Category I MLS is expected to begin in 2008.

Radiobeacons: Maritime and aeronautical nondirectional radiobeacons (NDBs) serve the civil user community with low-cost navigation. Selected maritime radiobeacons have been modified to carry differential GPS correction signals. This may cause these maritime radiobeacons to be unusable by certain aeronautical receivers. Maritime radiobeacons not used for DGPS are expected to be phased out by the year 2000.

Aeronautical NDBs serve two principal functions in the NAS: first, as a stand-alone nonprecision approach (NPA) aid at small airports; and second, as a compass locator, generally collocated with the outer marker of an ILS to assist pilots in getting on the ILS course in a non-radar environment. Stand-alone NDBs will be phased out beginning in 2008. NDBs needed as compass locators will be phased out when the underlying ILSs are withdrawn. Due to the wide use of NDBs in Alaska for en route navigation, a separate transition plan will be developed for this operating environment.